Certificate of Mailing or Transmission

I, the undersigned, hereby certify that this correspondence along with other possible documents has been electronically transmitted to the USPTO through its own EFS filing system on December 15, 2009.

Typed Name: Kevin D. Mccarthy

Date: December 15, 2009

Patent 0-04-204/ 14459/US/02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor:	Oren et al.
Serial no.:	10/519,321
Filed:	December 23, 2004
Title:	HIGHLY CONDUCTIVE ORDERED ION EXCHANGE MEMBRANES
Examiner:	Hu
Art Unit:	1796
Confirmation:	9122

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir/Madam:

RESPONSE

Applicant submits this response in reply to the office action mailed on June 23, 2009. Applicant also encloses a petition for extension of time to file this response with the appropriate fees.

Applicant also encloses for a second time, a change of address document so the USPTO will mail the office action to the correct address. The USPTO's web site confirms it received the first change of address document.

Claims amendment

1. Please amend the claims as shown on the attached marked-up pages:

- According to the Examiner's request, and in order to clarify to which polymer step (c) refers to, we amended claim 1 by adding the wording *"of step (b) above"*.

- Three important features, distinguishing the instant invention from the prior art membranes, have now been added in amended claim 1, namely the membrane thickness, the concentration range of the ion-exchange particles in

the resulting membrane, and the intensity of the electric field which is used. Support for the amendments can be found e.g. on page 27, lines 5-7 from the end of the page; on page 8, lines 6-9 and original claims 20 and 21.

- Claims 18-21 relating to membrane thickness, have been canceled, and the dependency of claim 22 has been amended.

- Typographical and wording amendments have been effected in claims 1, 6, 7, 10, 13, 22, 28-31 and 37. The amendments do not include any new subject matter and are intended to improve the clarity of the text.

Claim rejections - 35 USC § 103

2. Claims 1-31 and 37-38 are rejected as being unpatentable over Martin *et al.* (US 5,718,947), Aikman *et al.* (US 5,746,954) and Young *et al.* (US 5,863,610), in view of a combination of Roberts *et al.* (US 6,114,031), Takaoma *et al.* (US 2006/0263660 A1) and Morkved *et al.* (Science, vol. 273, pp. 931-932, 1990).

3. The Examiner notes that Martin, Aikman and Young provide processes for preparing membranes by depositing perfluorocarbon ion exchange polymers within polymeric substances. The Examiner admits that these publications do not relate to the use of an electric field in order to align the ionic nanostructures, or even the motivation to do so. Therefore, the Examiner cites Roberts, Takaoma and Morkved, alleging that these publications motivate a skilled artisan to use electric field in order to align nanostructures to improve the reliability, efficacy and mechanical strength of the resulting membrane.

4. We would first like to note that the instant invention, as defined by the amended set of claims, relates to a process for preparing heterogeneous ion-exchange membranes suitable for electrophoresis and fuel cells as proton conductive separators. The ion-exchange membranes produced according to the process of the instant invention are characterized in that the particle or domain threshold concentration needed for conductivity is considerably reduced compared to the known membranes of the prior art. Furthermore, the membranes of the invention are more stable and more conductive (see below) than known membranes.

Moreover, the membranes of the invention have lower swelling rate and higher permselectivity (e.g. last paragraph on page 3 and first paragraph on page 4).

Ion exchange particles swell to about 20-30% of their dry state volume (depending on the concentration of the solution they are in equilibrium with (the more concentrated the less swelling). Swelling in heterogeneous ion exchange membranes is largely dependent on the concentration of the ion exchange particles within the membrane matrix. As the concentration becomes higher, the swelling rate is larger. This swelling causes membrane shape changes and reduces the mechanical strength of the membranes. In our membranes less swelling is expected due to the lower concentration of the ion exchange particles.

Importantly, the process of the invention as defined by instantly amended claim 1 relates to the use of 20 to 40 %wt ion exchange particles in order to achieve a combination of high ion flux and conductivity compared to the prior art. According to the prior art, the preferred ion exchange particle concentration in the matrix is from about 50 to about 70 %wt. This difference is major and a skilled artisan would not anticipate that reducing the concentration of the ion exchange particles combined with applying an electric field will have any benefits.

5. Furthermore, the Examiner notes that Martin, Aikman and Young provide processes for preparing membranes by depositing perfluorocarbon ion exchange polymers within polymeric substances. However, all three publications relate to completely different membranes:

Martin relates to processes for coating objects with a thin coating layer less than a 100 nanometer thick, and desirably between 5 to 10 nanometer (column 3, lines 9-11). Moreover, Martin uses a dispersion containing only 0.5-2 %wt of the ionomer (column 14, lines 39-45), stating that beginning ionomer solids concentrations in the coating dispersion above 1 %wt do not yield appreciable improvements (column 15, lines 40-50). Martin further states that the thickness and uniformity of the produced coating layer appear to be optimum at an ionomer concentration somewhere between 0.5 and 3.0 %wt (column 17, lines 31-37). These characteristics are completely different from those of the instant membrane, i.e. thickness of between 10 to 500 microns, and 20 to 40 wt% of ion particles.

Aikman relates to a process for forming thin, durable diaphragm for chlor-alkali cell, having a thickness of

between about 5 and about 25 millimeters (column 7, lines 50-59). This is a much thicker membrane than the instantly claimed membrane, which is suitable for entirely different applications than the instant membrane.

Young relates to a process for depositing a fluorocarbonsulfonic ionomer on a support and to articles prepared therewith. According to Young, the articles are coated with a solution of 5-7.5 %wt perfluorosulfonic acid polymer (see Examples) and the resulting coating thickness is between 5 to 10 microns (Example 1). These coating characteristics are different than the instant membrane which comprises of 20 to 40 wt% of ion particles, and is considerably thicker.

Accordingly, a skilled artisan reading any of these three publications, will not be motivated to prepare a membrane comprising between 20 to 40 wt% of the ion particles, and most certainly will not try to reach a thickness of between 10 to 500 microns.

6. The Examiner further cites Roberts, Takaoma and Morkved as relating to the use of an electric field in order to align the ionic nanostructures in a membrane.

However, although Roberts mentions the use of an electric field, contrary to the Examiner's allegation, it does not suggest using electric field, and it considers such a step to be unfavorable. Rather, Roberts clearly states that *"there are several problems associated with electric-field poling"*, such as the high temperature needed, which might affect the order of the particles in the membrane, and the possibility of causing electrical breakdown. In fact, Roberts proposes to use the *Langmuir-Blodgett (LB)* processing (column 3, lines 23-31). Thus, a skilled artisan reading any of the cited art in view of Roberts, would not be motivated to apply an electric current when preparing a membrane. Therefore, Roberts is completely irrelevant.

Takaoma relates to proton conductive film for fuel cells, produced by applying an electric field to obtain periodically arranged pores, in order to allow high speed conduction, higher mechanical strength, and enhancing protonic conductivity of the fuel cell. However, Takaoma relates strictly to membranes having thickness of 10 microns or less (paragraph [0021]). Moreover, Takaoma does not relate to the intensity of the electric field that needs to be applied. Said intensity can also be influenced by the thickness of the membrane, and thus a skilled artisan reading Martin, Aikman and/or Young in view of

Takaoma, would not be motivated to produce the instantly claimed membrane, and even assuming he would, he could not have done so without substantive experimentation.

Morkved relates to a process for orienting microdomains in thin membranes using electric field, in order to improve the conductivity of the membrane. However, Morkved performed all experiments on a 100 nanometer thick membrane (see abstract)- this is more than 100 times thinner than our membrane. Onto said membranes, Morkved applied an electric field of 37 kV/cm (page 931, right column, line 9 from the end), which is much higher than the electric field we use (0.05 to 20 kV/cm). Accordingly, a skilled artisan reading Martin, Aikman and/or Young in view of Morkved, would not be motivated to use less than a 37 kV/cm electric-field intensity, and would also not assume that this method would be applicable to thicker membranes.

Conclusions

Since none of the cited documents or any combination thereof would have taught one skilled in the art the process for preparing the eclectically-modified membranes as defined in the present amended claim 1, or would have led a skilled person to such a process, the claimed process is believed to be non-obvious over the cited prior art. Since Examiner's objections and rejections have been addressed and the defects corrected, it is believed that all pending claims are allowable. Accordingly, we would respectfully ask the Examiner to reconsider his obviousness objection and allow the claims.

Respectfully submitted

Kevin D. McCarthy
Reg. No. 35,278

Roach, Brown, McCarthy & Gruber, P.C.
1920 Liberty Building - 424 Main Street
Buffalo, New York 14202